PROGRESS REPORTS
FROM
EXPERIMENT STATIONS

SEASON 1954-55

TANGANYIKA TERRITORY
LAKE PROVINCE

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PROGRESS REPORTS FROM EXPERIMENT STATIONS.

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For the 1954-55 season and subsequently the Progress Reports published in this series will be confined to those from territories in which members of the Corporation's staff are working. For 1954-55 the list will be:—

Cotton Research Station, Namulonge,
Sudan,
Kenya,
Tanganyika—Lake Province,
Tanganyika—Eastern Province,
Nyasaland,
Northern Nigeria,
Aden,
West Indies,
Survey of Reports

TANGANYIKA TERRITORY
LAKE PROVINCE
PROGRESS REPORT FOR THE SEASON 1954-55

COTTON SEASON.

Planting: Ukiriguru, 1st December 1954 to January 1955.
Lubaga, mid December 1954 to January 1955.
Cultivators, mainly January to late February 1955.

Picking: May until August 1955.

Legal uprooting date: 14th September 1955.

Rainfall for the period 1st October 1954 to 30th June 1955.
Ukiriguru: 22·65 inches.
Lubaga: 22·36 inches.

INTRODUCTION.

BY

J. E. PEAT.

Ukiriguru Station.

Rainfall.—1954-55 was dry, with droughty periods in the first half of March and again from late April into early May. Rains shut off in mid May—on the early side, but not exceptionally so. The general distribution was better than in 1953-54. The November-December planting rains were patchy; it was possible to plant on Ukiriguru, but many of the cultivators waiting for more steady planting rains had their planting delayed.

At Lubaga the rainfall in January was less than at Ukiriguru, with a more difficult distribution.

Staff.—Mr. J. E. Peat was on vacation leave from 8th May until 8th August 1955.

Mr. J. M. Munro was transferred to Nyasaland, leaving on 29th September 1955 after nearly six years at Ukiriguru. His services have been greatly appreciated, more especially in the critical examination of records, and he has played an important part in much of the work set out in this report.

Mr. K. J. Brown was posted to Ukiriguru and arrived on 15th July 1955.

Mrs. M. H. Arnold (Dr. K. M. Russell) started part-time duties at the end of October.

Mr. R. A. Brown, Field Officer (Agriculture), Farm Manager, proceeded on vacation leave on 21st March and returned to duty on 6th October 1955. His relief was Mr. B. J. Lumby, Field Officer (Agriculture), who served at Ukiriguru from 3rd March to 18th October 1955.

Mr. A. D. P. Angelini, Field Officer (Agriculture), went on vacation leave on 12th May 1955, and is not being posted to Ukiriguru again.

Mr. I. S. Mkwawa, Assistant Agricultural Officer, returned to Ukiriguru on posting on 14th July 1955.

Visitors.—His Excellency the Governor, Sir Edward Twining, visited Ukiriguru in November to congratulate the staff on the part that they had played towards exceeding the target of 100,000 bales in the Lake Province.

Lake Province Cotton.

The 1954-55 baleage was far and away the largest produced in the Lake Province. At the end of January 1956, the estimate, based partly on seed cotton bought, was 107,650 bales, over 16,000 bales more than the previous record production of 1953-54. The acreage recorded as planted was high—301,230 acres; but the provincial yield per 100 acres planted was lower than in the previous three years—roughly 36 bales per 100 acres, compared with an average of 42 bales per 100 acres. As will be mentioned later, a fair part of this reduction in yield might reasonably be attributed to the amount of cotton late planted. (Planting before the end of December, certainly before mid January, is recommended.) 175,000 cultivators grew cotton, each planting an average of 1·7 acres. (Figures from the Assistant Director of Agriculture, Mwanza.)

In none of the marginal fringe areas, mentioned in the 1953-54 report, was cotton growing successful. Pest damage in these areas caused heavy loss.

Given a maintained acreage and a continued interest by the cultivators, it should be possible to raise the Lake Province production above the 1954-55 record figure.

The 1955-56 planting season has been good, though the November/early December planting rains were patchy. A record demand for cotton seed for planting is reported.

Summary of the Main Results.

The husbandry results at Ukiriguru were generally very satisfactory. Continuing profit was obtained from land resting, from manuring with cattle manure, and from the use of phosphate, and

top-dressings of sulphate of ammonia on cotton gave striking results. In one trial a very high first residual response to organic manure was recorded. A most interesting result was the increased seed cotton production obtained where phosphate was added to land previously cropped with millet undersown either with cowpeas or with a mixture of *Crotalaria* sp. and *Tephrosia* sp., or to land previously cropped with velvet beans.

Throughout, the manurial and land resting results indicated the balance that is needed in farming the hill sands, between the phosphate requirement particularly—though probably other plant nutrients are also concerned—and nitrogen.

Uk55 was constituted and issued for multiplication on Kome Island. Uk48 and Uk51, in trials at Ukiriguru, Lubaga, and on district plots, gave increases of from 75 lb. to 132 lb. of lint per acre over Mz561. 0/334 and 1/667, the constituents of Uk55, yielded better than Uk48 and Uk51 in these trials.

The work on the Albar 51 crossing programme reached the stage when third backcross segregates were being studied.

The B_2B_{6m} programme was continued.

Nearly all the seed issued to cultivators was treated with Perenox. Serious bacterial blight was rare.

Pest damage in the Province was reasonable. Again, as in the previous two years, there were considerable populations of American bollworm on Ukiriguru, attacking maize and sorghum; very little attack on cotton was evident.

General Account of the Work for the Season.

BY

J. E. PEAT AND K. J. BROWN.

Husbandry.

Each season the picture becomes clearer how the productivity of these granitic areas could be raised considerably and relatively simply if the results obtained at Ukiriguru could be used in general agricultural practice by the African cultivators. On hill sand land, cattle manure, phosphate, sulphate of ammonia, land resting, tie ridging, in fact almost any treatment, results in profit—and in most cases a profit which lasts for a number of years. It is, therefore, worth considerable effort to get over to the growers the possibilities for improvement opened up by these agronomic results.

Two points should be made. Firstly, most of the responses have been measured with cotton as the indicator crop. Under some

conditions cotton responds differently from bulrush millet, the grain indicator crop—having somewhat different nutrient requirements, and a different cropping period. But over the range of experiments and over the years the general story is the same, with a larger profit from cotton. Secondly, reactions have to be studied over the years. The drought period in 1953-54 prevented profit, as measured in seed cotton, from being obtained from top-dressings of sulphate of ammonia. The reaction to the applied nitrogen was there, but the March drought resulted in greater wilting of the bigger, sappier plants, and therefore in crop loss. This past season the rainfall distribution was better; some of the responses to top-dressing nitrogen were very good. In general the biggest increases occurred where the land used was moderate to poor.

Time of Planting.

A considerable amount of the provincial cotton was planted late. As has been shown in other years, time of planting has a marked influence on yield. The provincial yield per acre was only 86% of the average of the last three seasons, namely 36 bales per 100 acres reported planted, compared with 42 bales per 100 acres in 1952, 1953, and 1954.

A simple time of planting demonstration at Ukiriguru on uniform land again showed a most marked drop in yield as a result of delayed planting. There was no obvious cross interference from pests and diseases. From planting at the beginning of December the yield was around 1,500 lb. seed cotton per acre; from planting towards the end of December the yield was not greatly reduced, around 1,250 lb. per acre; from planting just before mid January the yield had dropped to around 600 lb. per acre; and early February planting gave a yield of just over 400 lb. per acre.

It is not unreasonable to attribute the lower general level of provincial yields this past season to the high proportion of late planted cotton—mostly planted in late January, through February and even into March.

Land Resting.

Trial (6) entered its second cropping cycle this past season. Results are given in Table 1. The set-up of the trial was described in the 1950-51 report. All treatments gave approximately the same increase over control, around 300 lb. seed cotton per acre—an increase of 50%. As with all the experiments involving retreatments, residual responses from the fallow variants as well as from the compost and superphosphate applications would probably have played at least a small part.

TABLE 1.
MANURIAL AND RESTING CROP TRIAL.
Ukiriguru—Hill Sand—Trial (6).

6 blocks (cotton) of 5 plots of 1/27·3 acres. Cropping rotation—3 years fallow and millet: 3 years cotton. Compost applied 27th September, 1954 (also in 1948 and 1951). Phosphate applied 27th September, 1954 (also in 1948 and 1951).

5 foot ridges, 2 rows at 18″ spacing, 2 plants per hole. Cotton planted 22nd December, 1954.

First year of the second cropping cycle.	*First indicator crop of the second cropping cycle.*
	Seed cotton lb./acre.
A. Continuous cropping with millet in the resting cycle, cotton in the cropping cycle.	
Control	616
Compost—3 tons/acre ...	953
Double superphosphate — 75 lb./acre	931
B. "Tumbledown" fallow	921
Planted fallow	966
Sign. Diff. (P=·05)	125
S.E.	± 42·5

Third indicator crops were grown in Trial (7), (Table 1 in the 1953-54 report.) The controls, in the 8th year of cropping, were rotated cotton and millet, which yielded 971 lb. seed cotton and 695 lb. bulrush millet per acre. In the cotton section, all treatments still significantly exceeded the control, but no one treatment gave a response significantly greater than the others. Some of the increases from the bulrush millet treatment were not significant, and there were inconsistencies. The highest increase was the second residual response following the compost application in 1952-53 of 6 tons per acre, an increase of 285 lb. bulrush millet per acre.

TABLE 2.
ONE YEAR FALLOW EXPERIMENT.
Ukiriguru—Hill Sand—Trial (31).

4 blocks of 5 × 3 factorial, plots each 1/48·4 acres. Cropping rotation—1 year fallow, or cropped treatments. Cotton the indicator crop. Phosphate applied 4th February, 1954, and 13th November, 1954.

5 foot ridges, 2 rows at 18″ spacing, 2 plants per hole. Cotton planted 30th November, 1954.

Phosphate dressing—90 lb. double superphosphate/acre.

Mean yields: Seed cotton in lb./acre.

Treatments.	*First indicator crop.*		
	No phosphate.	*Phosphate Feb. 1954.*	*Phosphate Nov. 1954.*
Millet (Control)	584	710	643
Millet undersown with cowpeas ...	592	878	949
Millet undersown with *Tephrosia* and *Crotalaria*	590	974	790
Velvet beans	618	1114	979
"Tumbledown" fallow	767	786	888
Sign. Diff. of treatments ...		189	
S.E.		± 66	

Further to the trials including three year resting periods and a trial including a five year resting period, an important new series with one year resting periods has been started. The results from the first such trial are given in Table 2, Trial (31). (In fact the "tumbledown" fallow resting period amounts to around fifteen months, as the preceding crop of grain would have been off by July and the indicator cotton is not planted until November-December of the following year.) The trial was divided into three sections, treatments with no phosphate, treatments in which the phosphate at 90 lb. per acre double superphosphate was applied to allow the treatments themselves to benefit from the application, and treatments in which the phosphate was applied just prior to the planting of the indicator crop, cotton. It will be seen that without phosphate the only worthwhile treatment response was following the one year "tumbledown" fallow, an increase of 183 lb. seed cotton per acre over control—not quite significant. Phosphate applied to the control plots showed only a moderate response, and there was still less response to phosphate applied to the "tumbledown" fallow plots. But there were striking increases where legumes featured in the one year treatment, especially following one year of velvet beans. The assumption is that the nitrogen, made available presumably by nodulating legumes, could not be utilized in the absence of sufficient phosphate. This trial is being continued for a second year to measure any residual effects; a similar trial is now under its first indicator crop and a third similar trial is being established.

Manuring and Fertilisers.

Results from Trial (8), discussed in previous reports, are set out in Table 3. In the first section the responses were from the 10th residual crop—the eleventh indicator crop. The results were similar to those recorded in previous years. Residual responses from the lighter dressings were no longer apparent, but the responses from the heavier dressing of farmyard manure and from the heavy dressing of cotton seed ash were still significantly above the control. The second residual responses from the re-applied dressings were of the order that would be expected. Again the most striking result was the effect of applying sulphate of ammonia to the cotton seed ash plots, compared with a similar application to the control plots.

TABLE 3.

MANURIAL TRIAL.

Ukiriguru—Hill Sand—Trial (8).

8 blocks of 6 plots, treatments applied in November, 1944. Half plots, each 1/35·6 acres, were manured at the same rates in November, 1952, or received sulphate of ammonia at 175 lb./acre in March, 1953, 1954 and 1955.

5 foot ridges, 2 rows at 18" spacing, 2 plants per hole. Cotton planted 1st December, 1954.

Treatments.	*Yield of seed cotton in lb./acre.*		
	Eleventh indicator crop.	*Third indicator crop.*	*Yearly applications.*
	Treatments applied 1944.	*Treatments re-applied 1952.*	*S/ammonia applied 1953, 1954 & 1955.*
Control—no manure	480	—	508
Compost—3 tons/acre	401	584	—
Farmyard manure—3 tons/acre	519	665	—
Compost—7 tons/acre	619	701	—
Farmyard manure—7 tons/acre	682	977	—
Cotton seed ash—1½ tons/acre	729	—	1238
S.E.	± 57	± 62	± 62
Sign. Diff. (P=0·05)—			
in the same column	164	177	177
in the same line ...		156	
not in the same line or column ...		176	

Interaction: Ash × Nitrogen +236 S.E. ±44·5

In Trial (38), started this past season to try to get response curves with four rates of double superphosphate and four rates of sulphate of ammonia, no worthwhile responses were obtained. The trial did not satisfy the F test, but the level of fertility was high. The control yield was 1,230 lb. seed cotton per acre.

At Lubaga all that appears to be worth doing on the "ibushi" and "ibambasi" soils is to prevent the soil from eroding and, as will be mentioned later, to crop on tied ridges instead of on the flat. None of the rotation or resting treatments tested there has produced any worthwhile result, while the profit from tie-ridging compared with flat cultivation is generally considerable.

At Ukiriguru the rotation trial, Trial (19), has been discontinued, as no major differences have been found between continuous cotton or bulrush millet and one and one, one and two, and two and two rotations. The past three seasons have not shown bacterial blight infection from cotton trash, which in the wet 1951-52 season was suspected to be the main factor in reducing yields where cotton was

grown continuously or every second year. This aspect is being studied in direct bacterial blight work.

Trial (9), Table 4, was described in the 1953-54 report. This year the second indicator crop of this manuring cycle was grown; to the portion receiving nitrogen, 200 lb. of sulphate of ammonia was applied. The responses to organic (residual), and nitrogen (direct), were very striking. The control mean was 879 lb. seed cotton per acre. Plants in the control plots were small but cropped effectively.

TABLE 4.

NPD EXPERIMENT.

Ukiriguru—Hill Sand—Trial (9).

$2 \times 3 \times 2$ factorial with NPD and ND interactions partially confounded, testing all combinations of:—

n_0, n_1 0, 200 lb. sulphate of ammonia/acre.
d_0, d_1 0, 6 tons compost/acre.
p_0, p_1, p_2 0, 75, 150 lb. double superphosphate/acre.

6 replications in 12 blocks of 6 plots, each 1/69·7 acres. Compost and phosphate applied 15th and 16th September, 1953. Nitrogen applied 23rd February, 1955. Cotton planted 3rd December, 1954.

FIRST RESIDUAL YEAR—NITROGEN RE-APPLIED.

Mean yields: Seed cotton lb./acre.

	(1)	*d*	*n*	*nd*
p_0	879	1635	1404	1831
p_1	917	1644	1629	2042
p_2	1078	1764	1776	2154
Sign. Diff. (P = ·05)			250	
S.E.			± 88	

The first residual response from phosphate was of the order expected, but by contrast that from organic manure, 756 lb. seed cotton per acre, was very high, exceeding anything previously recorded and causing a reiteration of the query, wherein lies the residual effect of organic manure? The application of 200 lb. sulphate of ammonia to the controls gave a mean increase of 525 lb. seed cotton per acre—also very high and much higher than anything previously recorded. (In Trial (26) there was in the control plots an increase of 260 lb. seed cotton per acre from the application of 200 lb. sulphate of ammonia per acre. With these two results contrast Trial (8), where in the last two seasons there has been no increase from the application of sulphate of ammonia to the controls.) In Trial (9) 200 lb. sulphate of ammonia applied to the first residual p_2 plots gave an increase over the mean control of 897 lb. seed cotton per acre, doubling the control yield. The highest yield, 2,154 lb. seed cotton per acre, came from the first residual

organic plots, plus p_2 and top-dressed with nitrogen. There was a negative interaction between organic manure and nitrogen, and a positive interaction between phosphate and nitrogen.

TABLE 5.

NPD EXPERIMENT.

Ukiriguru—Hill Sand—Trial (26).

5 replications of 2 × 2 factorial, with split plots of 1/69·7 acres giving 4 nitrogen treatments. Compost and phosphate applied 29th November, 1952. Sulphate of ammonia applied 24th February, 1955, at flowering.

5 foot ridges, 2 rows at 18″ spacing, 2 plants per hole. Cotton planted 16th December, 1954.

p_0, p_1	0, 150 lb. double superphosphate/acre.
d_0, d_1	0, 6 tons compost/acre.
n_0, n_1, n_2, n_3,	0, 50, 100, 200 lb. sulphate of ammonia/acre.

SECOND RESIDUAL YEAR—NITROGEN RE-APPLIED.

Mean yields: Seed cotton in lb./acre.

Nitrogen treatments.	*Third indicator crops from dressings of compost and phosphate.*				*Nitrogen means.*
	(1)	*d*	*p*	*pd*	
No nitrogen ...	813	1111	995	1259	1045
50 lb./acre ...	903	1354	1293	1340	1223
100 lb./acre ...	1008	1279	1340	1623	1313
200 lb./acre ...	1073	1184	1282	1614	1288
Sign. Diff. (P=·05)— in the same column			209		105
in different columns			359		S.E. ± 36·9
P and D means ...	950	1233	1228	1460	
Sign. Diff. (P=·05)			301		

Main effects:

P + 253
D + 257 S.E. ± 97·7
PD − 26

In Trial (26), Table 5, are set out the second residual results, third indicator crops, from applications of compost and phosphate made in 1952, with nitrogen applied at four rates this past year. This experiment, but with nitrogen applied at different times instead of different rates, is described in the 1953-54 report. The residual responses and the nitrogen responses were satisfactory, with the mean control yielding just over 800 lb. seed cotton per acre.

Ridge Tying.

In Ukiriguru Trial (16), Table 6, poor ridges not tied compared with good ridges tied, the results were generally similar to those obtained in recent years, an increase of 315 lb. seed cotton per acre as a result of good ridges tied—1,150 lb. to 1,465 lb. For the bulrush millet section there was an increase of 220 lb.—804 lb. to 1,024 lb.

Table 6.

Ridge Tying Trial.

Ukiriguru—Hill Sand—Trial (16).

10 blocks (5 cotton—5 millet) of 4 plots 1/29·0 acre. Cropping rotation—cotton and millet alternate, every year.

5 foot ridges, 2 rows at 18″ spacing, 2 plants per hole. Planted 30th November, 1954 (cotton); 10th January, 1955 (millet).

Nine years' treatments, 1946-47 to 1954-55.	*Mean yields: lb./acre.*	
	Seed cotton.	*Millet grain.*
Poor ridges not tied	1150	804
Good ridges tied	1465	1024
Sign. Diff. (P = ·05)	124	113
S.E.	± 39	± 35

In a second Ukiriguru tie-ridging trial stands were exceedingly irregular, and no profit appeared from the tying. There was a substantial increase from the sections that had been manured compared with the non-manured.

At Lubaga there were responses, similar to those recorded for the last few years, to ridge tying compared with flat cultivation, more particularly with cotton. On the "ibambasi" (hard pan soil), flat cultivation yielded 330 lb. seed cotton per acre, 3 ft. tied ridges 711 lb. and 4 ft. tied ridges 673 lb. The sorghum portion of the trial did not satisfy the F test. In an "ibushi" (dark old lake bed soil) trial, which did not satisfy the F test, cotton on 3 ft. and 4 ft. ridges tied gave a 60% increase over flat cultivation, with the mean of the flat plots yielding 473 lb. seed cotton per acre. In another trial the flat yield was 266 lb.; 3 ft. ridges tied and 4 ft. ridges tied gave an average of 660 lb. seed cotton per acre, more than double the yield on the flat, with no difference between the 3 ft. and the 4 ft. ridges. In the sorghum section of this trial the flat cultivation yielded 788 lb. sorghum per acre. There was no difference between the 3 ft. and 4 ft. ridges tied, which yielded an average of 1,127 lb. per acre—an increase of over 40%.

Cotton Breeding.

There are three cotton breeding programmes at Ukiriguru: a continuation of the original programme, sorting out segregates in the Mwanza "Local" material; the sorting out of segregates in the Albar 51 programme of adding resistance to bacterial blight to the best of the Ukiriguru strains; and a third programme of adding bacterial blight resistance by crossing the best Ukiriguru strains with BAR 14/38 $B_2\hat{B}_{6\,m}$ Sakel). These two programmes of adding bacterial blight resistance are discussed in the section "Bacterial Blight".

This past season, the Lake shore general area was under Uk51, with Uk48 in inland areas. For 1955-56 the provincial crop is all

Uk51, except for a small multiplication on Kome Island of the new Uk55.

As was mentioned last year, with the range of peasant growing conditions it is difficult to estimate what the contribution of the two seed issues Uk48 and Uk51 has been to the past season's record crop. In the main trial at Ukiriguru, where Uk48 and Uk51 had a mean yield of 544 lb. lint per acre, they yielded 132 lb. more than Mz561, an increase of 32%. At Lubaga, where their mean yield was 133 lb. lint per acre, the increase was 88 lb. In nine of the most uniform district plots scattered over the province, not necessarily the highest yielders—but incidentally giving a mean for Uk48 and Uk51 of 418 lb. lint or just over a bale an acre—they yielded 75 lb. more than Mz561, an increase of 22%. This is a satisfactory record and shows the improvement in production that the issue of these strains can effect with reasonable husbandry and timely planting. It should be noted that the nine district plots were peasant cultivated.

TABLE 7.

VARIETY TRIALS.

Yields of lint in lb./acre.

Family	*Strain.*	*Ukiriguru main variety trial.*	*Lubaga.*	*Mean of 9 district plots.*
	Mz561	412	45	343
	Control { Uk48	549	113	409
	Control { Uk51	539	153	426
	Control (mean)	*544*	*133*	*418*
	Uk48 ex Malampaka Ginnery	517	111	—
	Uk51 ex Buchosa Ginnery	547	144	—
	Potential Uk55 (50% 1/667 & 50% 0/334)	591	288	—
8/290 (ex 6/320)	0/328	653	198	454
	0/334	595	260	463
	1/667	599	248	459
7/367 (ex L.4/112)	0/457	527	143	412
Sea Island × U4	1/685	581	231	446
	1/686	553	215	417
Sign. Diff. (P. = ·05)		56	37	
S.E.		±24·3	±13·2	

Considering the Ukiriguru main trial, two of the leading members of the 8/290 family, 0/334 and 1/667, yielded 51 lb. and 55 lb. lint per acre more than the mean of Uk48 and Uk51—around 46% up on

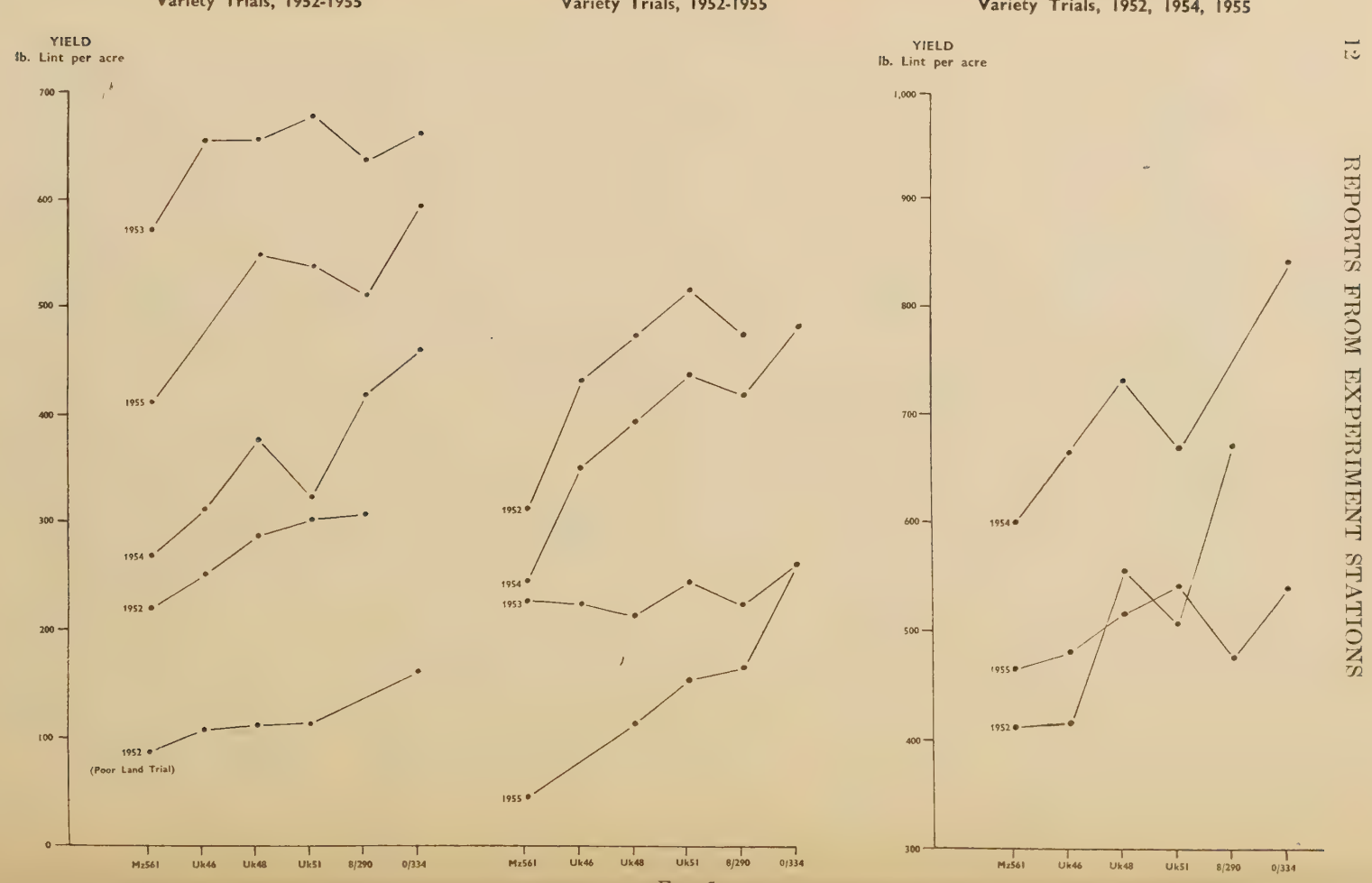
UKIRIGURU
Variety Trials, 1952-1955
YIELD
lb. Lint per acre
700
600
500
400
300
200
100
0
1953
1955
1954
1952
1952
(Poor Land Trial)
Mz561
Uk46
Uk48
Uk51
8/290
0/334
LUBAGA
Variety Trials, 1952-1955
1952
1954
1953
1955
Mz561
Uk46
Uk48
Uk51
8/290
0/334
ARUGONGO
(District Plot Geita)
Variety Trials, 1952, 1954, 1955
YIELD
lb. Lint per acre
1,000
900
800
700
600
500
400
300
1954
1955
1952
Mz561
Uk46
Uk48
Uk51
8/290
0/334

FIG. 1

Mz561. At Lubaga, with comparatively low yields, they were 127 lb. and 115 lb. lint per acre better than the mean of Uk48 and Uk51; and over the nine district plots 45 lb. and 41 lb. better—34% up on Mz561.

The new Uk55 consists of 50% each of 0/334 and 1/667. Several members of the 5/57 and the 6/318 families still continue as possibles, though for a number of reasons a mixture of 0/334 and 1/667 was considered the safest issue.

Two U4 × Sea Island crosses, 1/685 and 1/686, are amongst the top yielders.

0/457 is the best continuing member of the 7/367 family ex L4/112, originally selected at Lubaga out of Mz457, members of which are doing well at Namulonge. In the Lake Province 0/457 is not in the top class; possibly the very qualities of free flowering which may favour it in Uganda are not favourable qualities under the harder Lake Province conditions.

The general story this year is that the greatest yield increases between strains have shown up in the inland comparisons rather than in the better grown Lake shore comparisons. This is not always so. Fig. 1 illustrates the comparative yields over the last four years, of Mz561, the seed issues, Uk46, Uk48 and Uk51, 8/290 and the daughter strain 0/334, at Ukiriguru, Lubaga, and Arugongo (probably the best Lake shore district plot). It will be seen that though the general story is satisfactory and the trend similar in these three areas the relative behaviour of the strains varies from year to year, making any generalization about percentage increase applicable only to the particular area for the particular year.

Straight selection in the Ukiriguru breeding material was slowed down from 1951 onwards. It was thought that a far enough stage had been reached to allow work to be concentrated on the segregating crossing programme with Albar 51, and later with the new programme with BAR 14/38. This past season, dipping back into bulks of 0/334, 1/667, 1/686, 0/328 and 0/331, taking new single plant selections for reasonable cropping and leaf hair (though the general field appearance of these was reasonably uniform) and examining the types of seed coat fuzz, the percentage of seed coat damage, lint index, seed weight, and ginning percentage, surprising variations were recorded, six selection generations away from Mz561. Single plant lots have been planted this 1955-56 season, and replicated comparisons are being made of groups of high and low seed coat damage and high and low lint index to find out the extent to which these differences are genetic, or positional in the choosing of the recorded plants. If genetic, work will have to proceed on the segregation of these characters and segregation in spinning qualities.

Seed of all lots is now examined for the percentage of seed coat damage. There are considerable variations between lots. Lots showing heavy damage are discarded; but many of the best lots for this character have other less valuable qualities. The B.C.I.R.A. Shirley Institute tests are of special help in assessing fibre values and spinning qualities, especially yarn appearance, in the middle group for percentage seed coat damage. The general Shirley Institute criticism of Lake Province yarn appearance is based rather on differences in regularity in drawing than on excessive seed coat nep, though seed coat nep is present and is reported as more serious in some strains.

Shirley Institute figures for standard fibre weight per cm. in the material now being handled run from around 175 to just over 200. It is interesting to note that a strain 0/320 ex 6/320 (from which 8/290 and the daughter strains 0/334 and 1/667 were derived), three selection generations away from Mz561, should suddenly show up with the entirely exceptional standard fibre weight of 234 resulting in a corrected lea count × strength product of 1602 compared with 1800 to 2000 for the other lots in that testing from that particular trial. This is the only fibre test recorded for this strain.

At Ukiriguru and Lubaga, in the main variety trials, Uk48 which had been grown at Ukiriguru each season since 1948-49, i.e., over six seasons, was compared with Uk48 from the Malampaka ginnery, six seasons in commercial cultivation since the original distribution. Similarly Uk51 grown for three seasons at Ukiriguru was compared with Uk51 from Buchosa ginnery, three seasons in commercial cultivation. It could not be said for either issue that there was evidence of mixture or deterioration in commercial growing as reflected in yield, nor was there evidence of any build-up of naked or semi-naked seeds. "Local" and Mz561 show about 10% of naked seeds; Uk46 1-2%; Uk48 a trace, and Uk51 none.

Diseases.

BY

M. H. ARNOLD.

Bacterial Blight (*Xanthomonas malvacearum*).

Albar 51 Crossing Programme.—The original object of adding bacterial blight resistance to the best of the Ukiriguru strains was expanded, soon after a start had been made, to exploit the great variability which was present in the earlier progenies. To this end, material has been selected at each stage in the backcrossing progression, and continued as pedigree lines.

Selections derived from F_1 and first backcross plants, grown this season as F_4's and F_5's, showed a wide range of habit. Derivatives from

second and third backcrosses, however, showed close resemblance to their Ukiriguru parents in both habit and jassid resistance.

Selfed or naturally pollinated single plant progenies, which had been grown out of season, were put into trials planted in February. In these trials, where the mean yield was 1,039 lb. seed cotton per acre, the yields of derivatives from third backcrosses were distributed about that of Uk51 with none significantly higher. Of these selections, those derived from crosses made with the 8/290 family gave the best combination of high yield with high jassid resistance. The 6/318 derivatives tended to be poor for jassid resistance, whilst the 7/367 lines were disappointing in yield.

Some of the derivatives of first backcrosses which were included in these trials were of outstanding habit and jassid resistance, two yielding significantly higher than Uk51. These lines and more recent selections made within them will be studied closely in the coming season.

Single plant progenies were in general much more uniform than in the previous generation. The unbalanced types, to which reference has been made in previous reports, have largely disappeared in these later selections. Single plant selection is being continued to eliminate them completely, and so that homozygosity for resistance may be approached as quickly as possible. This means that a large number of progenies have to be continued, and it is becoming increasingly important that as much information as possible be obtained in the first year after selection. For this reason, fifteen single plant progenies have been laid aside for testing in replicated progeny rows in the coming season. The primary object of this will be to investigate the practical difficulties of the technique with a view to its much wider use if successful.

TABLE 8.

ALBAR 51 BACKCROSSING TRIAL.

Design: 4 × 4 balanced lattice. Plot size 5 ft. × 50 ft.
Spacing: 2 rows per ridge at 18". Planted: 7th December, 1954.

	Yield of Lint lb./acre.	*Increase over Albar 51.*
Uk51	615	+206***
0/334 (Highest yielding strain in 1953-54)	582	+173***
Mean of two Albar 51 lines	409	0
Mean of three Ukiriguru parental strains	577	+168***
Mean of three F_1 derivatives ...	477	+ 68
Mean of three 1st back-cross derivatives	577	+168***
Mean of three 2nd back-cross derivatives	626	+217***

*** Increase significant at $p < .001$.

In order to obtain some estimate of the overall progress achieved by backcrossing and selection, a trial was laid down in which three Ukiriguru strains, which have been used as recurrent parents, were compared with bulked derivatives of their F_1, first backcross and second backcross progenies. The results, which are summarized in Table 8, show that an adequate level of yield is restored after one or two backcrosses.

A range of material has been carried to the fourth backcross using as backcross parents the strains which proved the highest yielders in the 1953-54 strain trials. The backcrossing will not be taken further for the present. The immediate objective is to obtain a better assessment of the wide range of material now being handled.

Crossing Programme with BAR 14/38.—The addition of the gene B_{6m} to a small range of the best Ukiriguru strains formed the major part of the out-of-season work. This material has now reached the first backcross stage. The F_1 plants appeared to be immune to stem and leaf attack, and showed marked vigour.

Seed Treatment.—Yield trials, similar to trials "A" and "B" described in last season's report, were laid down on new sites. In these trials untreated seed was compared with seed treated with Perenox, Perecot 45 and Agrosan GN5, applied at the rate of 1/300 parts by weight.

Seedlings removed from the trials as thinnings were scored for the incidence of cotyledonary infection. (These seedlings may not have been taken at random; there may have been some selection of infected plants during thinning.) The results are shown in Table 9. The percentage of vascular infection* is shown separately because this type of infection is thought to result in greater damage to the plant than non-vascular attack.

As observed in previous trials, the mercurial dressing, Agrosan GN5, was more effective than the copper dressings, Perenox and Perecot 45.

The higher incidence of infection in Trial "B" (poorer, non-rotated land) as compared with that in Trial "A", is interesting. The trials were planted on the same day, with seed from the same bulks, and the scoring was carried out over the same period. The possibility that some of the infection in Trial "B" might have arisen from trash cannot be eliminated, but it is thought that soil conditions may also have been a factor. Trial "B" was planted near the "itogoro" or seepage zone of the Ukiriguru catena, whereas Trial "A" was on more typical hill sand.

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*Wickens, G. M. "Vascular infection of cotton by *Xanthomonas malvacearum* (E. F. Smith) Dowson". Ann. appl. Biol. 44 (1): 129-137, 1956.

TABLE 9.

SEED TREATMENT TRIALS.

Percentage of seedlings showing cotyledon lesions caused by *X. malvacearum* at 28-33 days after emergence.

	Trial "A" (7 replications)				*Trial "B"* (7 replications)				*Booth drum mixer* (Ten paired samples)			
	% *Infection.*		% *Vascular infection.*		% *Infection.*		% *Vascular infection.*		% *Infection.*		% *Vascular infection.*	
	Mean	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*	*Mean*	*Range*
Untreated	46·0	23-58	17·4	12-23	70·9	63-88	47·9	21-55	32·1	19-48	13·5	5-26
Perenox 1:300 w/w ...	2·7	0-7	1·0	0-4	7·0	4-10	3·8	0-9	5·0	0-11	0·8	0-3
Perecot 45, 1:300 w/w ...	3·9	0-8	2·6	0-7	4·8	1-15	2·0	1-3				
Agrosan GN5, 1:300 w/w	0·6	0-3	0·3	0-2	0·3	0-2	0·2	0-1				
Average size of sample ...	96				95				68			

In both trials, pronounced growth irregularities appeared and the yield results suffered accordingly. In Trial "A" the mean increase due to seed treatment was 20% (significant at $p < 0.05$) and in trial "B" there was an increase of 10% which was not significant. The mean yields of the "untreated" plots were 745 and 578 lb. seed cotton per acre respectively. Comparisons between individual seed treatments were of doubtful value in view of the high experimental error. The co-efficients of variation, which were 25% and 23%, were probably increased by the lay-out employed, in which each plot was separated from its neighbour by 20 ft. strips of sorghum and velvet beans. These were included as barriers to the spread of infection.

All seed issued to native growers was treated with Perenox by the Department of Agriculture. Treated and untreated samples were taken at approximately weekly intervals from Malampaka ginnery, where one of the Booth drum mixers was being operated. Ten such paired samples were planted and the seedlings scored for the incidence of cotyledonary infection. The results are shown on the right of Table 9.

Although there were reports of local epidemics of bacterial blight in the Province, visits to these areas revealed that in all cases the main damage was due to other causes. In extensive tours of the cotton growing areas, the only serious bacterial blight observed was in two native holdings near Ukiriguru. It was subsequently ascertained that these had been planted with untreated seed obtained from the Station ginnery.

Spread of Infection.—The spread of infection from plot to plot was investigated in an experiment in which a block of land, where cotton had not been grown for four years, was divided into 56 plots, each 30 ft. square. The whole block was planted with acid delinted seed; that planted in the central two plots had been inoculated with *X. malvacearum,* and the remainder treated with Agrosan GN5, in order to give the maximum control of seed-borne infection. The seedlings at 23-36 days after emergence showed 64% and 0·2% cotyledonary infection respectively.

At 77 days after emergence, scores of angular leaf spots indicated gradients of infection radiating from the main disease focus. Further scores at 94 days after emergence were complicated by the occurrence of "peaks" of infection which could not easily be related to the overall gradient. At this stage, the gradient was from around 3·5 infected leaves per plant at the infection focus to less than 1·0 at the edges of the block, with scattered peaks showing up to 4·5 infected leaves per plant. (This score was based on 66 samples of 30 plants taken over half of the experiment.)

The leaf infection recorded at these two stages did not develop into the more serious forms of the disease to any marked extent, and it did not appear that the plots adjacent to the infection focus suffered greater loss of crop than the more distant plots. The yields are summarized in Table 10, together with the proportions of grade "C" seed cotton.

Table 10.

Influence of the Spread of Infection on Yield.

	Mean yield seed cotton lb./acre.	% *Grade "C" seed cotton.*
Central 2 plots (inoculated seed)	1145 ± 86	5·2
1st ring of 10 plots (disinfected seed)	1277 ± 54	6·2
2nd ring of 18 plots (disinfected seed)	1240 ± 39	6·9
3rd ring of 26 plots (disinfected seed)	1310 ± 35	7·0

The plots grown from disinfected seed showed a mean increase of 12% over the two central plots. This is comparable with the increase due to acid treating shown in a trial last season at a similar level of fertility.

Trash-borne Infection.—In series of non-replicated plots on land assumed to be free from trash, comparisons were made of the incidence of bacterial blight after the application of trash at various rates and in different ways. Trash from Ilonga, where the incidence of bacterial blight is known to be slight, was included as a "control" for the possible manurial effect of large applications of trash.

Inferences from the results are of value chiefly as pointers for the design of more precise experiments. The main indications were:—

(a) In plots where Ukiriguru trash was applied at the rate of about 1,000 lb. per acre, from 28% to 90% of seedlings showed leaf infection 38 days after emergence, whilst in plots where no trash was applied the average was 2·6%. (The seed was acid treated.)

(b) Plots where Ilonga trash was applied at the same rate gave from 1·4 to 6·6% infected plants.

(c) With trash applied at a depth of about three inches along the centre of the ridge, plants on top of the ridge (whose roots grew through the trash) showed less leaf infection than plants grown on either side of the ridge.

(d) There were indications that some seed dressings applied to acid treated seed resulted in increased infection from trash.

In no case did the infection develop into serious "blackarm". Stem lesions developed only to a limited extent, and scores of their intensity at 170 days after emergence, showed no major differences between "trash" and "no trash" plots. From the yield data, it is doubtful if infection from trash had any effect on yield. The level of fertility was fairly high, the average yield being 1,165 lb. seed cotton per acre.

General.—As work on bacterial blight at Ukiriguru progresses, the complexities of the disease become increasingly apparent. Differences in conditions at the time of germination may cause great differences in the incidence of infection in seedlings grown from samples of the same bulk of seed. Infection which is first observed on leaves may spread to form severe lesions on stems and branches under one set of conditions, whereas under other conditions there may be no such development. Infection from trash appears to be important in some seasons but not in others. The marked interaction of soil fertility and the severity of the disease is frequently observed.

In spite of these complexities, and of the difficulties of field technique when dealing with a disease of this type, the results from yield trials and from observation plots have been consistent in showing increases in yield due to seed treatment.

The fear has been expressed that the infection remaining in plants grown from treated seed may build up to epidemic proportions and render seed treatment valueless. The rapid development of epidemics has not been observed at Ukiriguru during the past three years. In the yield trials which have been carried out, the disease could not be described as very severe even in the untreated plots.

Observations have indicated an association between cotyledonary lesions on seedlings and the occurrence of stem lesions at the cotyledonary node later in the life of the plant. Samples of plants from various trials were scored for the incidence and severity of stem lesions, when boll opening was beginning. The lesions were graded according to the geometric series 1, 4, 9, 16, 25 where "1" represented a trace of a stem lesion, and "25" a lesion serious enough to cause stem breakage. The numbers in each grade were recorded for each sample at the cotyledonary node and for the rest of the main stem. These numbers were multiplied by their respective grades and summed for each treatment. The results, expressed as "lesion-grade products per hundred plants", are shown in Table 11. These figures show that the

effect of seed treatment has persisted in the region of the cotyledonary node and to a less extent for the rest of the main stem.

TABLE 11.

STEM LESIONS.

Lesion-grade products per 100 plants recorded on main stems at 128-144 days after emergence.

	Trial "A" (*Means of 6 replications*)				*Trial "B"* (*Means of 6 replications*)			
	Untreated	*Perenox*	*Perecot 45*	*Agrosan GN5*	*Untreated*	*Perenox*	*Perecot 45*	*Agrosan GN5*
Cotyledonary node	376	38	57	40	388	75	57	16
Rest of main stem	670	258	544	149	928	441	704	210
Size of samples	34				34			

Under Lake Province conditions, where long dry spells are a feature of the climate and tend to arrest the development of epidemics, it is thought that stem lesions at the cotyledonary node may be important. In severe cases, the stem breaks at this point and the plant dies. In other cases the stem tissues are damaged and normal growth is suppressed. Where there is a severe lesion at the cotyledonary node compensating shoots are seldom formed. This is in contrast to growth higher up the plant, where axillary shoots, which escape infection, can often be seen growing from the node immediately below a stem lesion. Hence it would appear that the plant which is infected later on, either from trash or by spread from a nearby plant, has a better chance of compensating for the damage than has the plant which is infected at the cotyledonary node from the seed.

Problems which need clarification are (a) the importance of vascular infection, (b) the nature of the observed suppression of growth associated with infection at the cotyledonary node, (c) the precise conditions which cause epidemics, and (d) the frequency with which such conditions occur in the Lake Province.

Wilt (*Fusarium oxysporum f. vasinfectum*).

Wilt occurred again in the same area of Geita district in which it was discovered last year. It did not appear to be spreading.

Pests.

BY

J. E. PEAT.

American Bollworm.—As in 1953 and 1954, from mid February until the beginning of May, considerable to very large populations of American bollworm were present on the Botanist's sorghum. They were particularly noticed on the heads protected with bags, where several larvae could be found on one head, and in trap plantings of maize where 70 to 100 larvae were counted per 100 plants. In spite of this, American bollworm attack on cotton was quite unimportant, though 4,000-6,000 flared squares per acre were reported from one area of the Station at the beginning of March. Sorghum and maize flowering seem to be much more attractive to the egg-laying moths, even where cotton nearby is flowering freely. The presence of these large populations on sorghum and maize illustrates the delicacy of the balance between the attractiveness of these crops and cotton; an upset in this balance could cause heavy loss to cotton, as has happened in some years. In the last three years the maize trap plantings and the sorghum plantings have taken the egg-laying. Nowhere in the province was heavy American bollworm attack on cotton reported.

Jassid.—Jassid was unimportant in the damage that it caused. Only occasionally was slight damage reported.

Stainers.—Again, the percentages of grade "C" were taken as indicators of the amount of stainer and *Calidea* damage. In general this is probably correct, but bacterial boll rot must also be a factor. On this basis stainer damage was not important. At Lubaga, populations were late in building up, but the percentage of grade "C" in the main variety trial was 46%. In the main Kwimba district plot trial the percentage of grade "C" was 35%, possibly linked with kapok (*Eriodendron anfractuosum*) trees in the area. At Ukiriguru the percentage of grade "C" was around 10%. In most of the district plots the percentage was under 10%, in many as low as 3%-5%.

In marginal areas outside the established main cotton region of the South-East Lake Province, e.g. North Mara and Kahama, stainer damage was reported as crippling; and this, together with bollworm loss, made cotton growing very unattractive in spite sometimes of reasonable husbandry.

Lygus.—*Lygus* is reported to have caused loss in Western Ukerewe Island and parts of Musoma.

Aphis.—Comparatively late in the life of the cotton plant, aphis was reported as locally severe in Musoma, Kwimba, and Ukerewe Island, developing after the cessation of the rains in mid May. Damage was accentuated by the amount of late planting. The blackened honeydew-affected appearance had been reported as "blackarm damage".

Pink Bollworm.—Pink bollworm was reported only on the Ukiriguru out-of-season cotton used in the bacterial blight crossing programme.

Soil Chemistry.

BY

P. H. LE MARE.

Soil analysis has been confined to a preliminary examination of the surface soil in plots of the organic manurial trial—Trial (8). Samples were taken from the top six inches of the ridge in February 1954. On the plots which had received only the original applications of manure in 1944 there had been 10 years for the manures to become incorporated with the soil; surface samples may therefore be used with some confidence. Other plots received a re-application of compost and farmyard manure in 1952, so that surface samples taken in 1954 are probably unreliable. Only analyses of soil from plots which had received manures in 1944 are considered below.

Phosphorus, extracted by shaking with 0·3 N HCl for 3 minutes, was as low (0·3 mg P per 100 g soil) in the plots manured in 1944 as in the plots which had never been manured. Soil in plots which had received $1\frac{1}{2}$ tons of cotton seed ash in 1944 still contained, in 1954, 2·4 mg P per 100 g soil.

Exchangeable base content (K + Ca + Mg) ranged from 1·6 m.e. per 100 g soil where 3 tons per acre of compost had been given, to 2·5 m.e. per 100 g soil where 7 tons of farmyard manure were applied in 1944. The value in the absence of manure was 1·9.

Yields of seed cotton in 1953 and of millet grain in 1954 were very closely related to the exchangeable base content of the soil for all treatments except the cotton seed ash, which gave a much higher yield, presumably due to the higher P content of the soil.

These analyses suggest that, in the hill sands, the long term residual effects obtained from organic manure may be due to a general improvement in the nutrient status of the soil rather than to a specific increase in phosphate, as has formerly been supposed.

The preliminary nature of these analyses must be emphasised. The appointment in January 1956 of a graduate chemist from Makerere College, Mr. A. M. Kabaara, will make possible a full investigation of the chemical and physical basis for the field data, obtained over the past dozen or so years, on manuring, fallowing, and ridge-tying on the hill sands at Ukiriguru.

Appendix.

Origin and Special Characteristics of the Main Cotton Strains Mentioned.

Lake Province "Local"	The commercial cotton in the Province prior to the issue of Mz561—mainly of Uganda Local origin.
Mz561	A straight selection from "Local", first multiplied in the 1939-40 season.
Uk46	A seed issue with fair jassid resistance, made up of the best four Ukiriguru strains and the best three Lubaga strains available at the time, first multiplied in the 1946-47 season.
Uk48	A seed issue made up of four strains of better jassid resistance than Uk46, first multiplied in the 1948-49 season.
Uk51	A seed issue made up of seven strains with jassid resistance, first multiplied in the 1951-52 season.
5/57	A derivative of 3/17, itself a straight selection from "Local".
6/318	Ex 4/35, itself a derivative of Mz561.
7/367	Ex Lubaga L4/112, ex originally Mz457.
0/457	Ex 7/367.
8/290	Ex 6/320, one of the heaviest cropping Ukiriguru strains—Ex 4/35.
0/328, 0/331, 0/334, 1/667	Ex 8/290.
1/685, 1/686	Ex Barberton U4 × Sea Island.
Albar 51	General term for 1951 selections from Nigerian Allen, highly resistant to bacterial blight; ex Dr. J. B. Hutchinson.
BAR 14/38	B_2B_{6m} Sakel ex Shambat.

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